TITLE OF THE INVENTION

Munition device

FIELD OF THE INVENTION

The present invention generally concerns a munition device and more specifically for example a multipurpose projectile, warhead or missile with an ALP module.

The term munition device is therefore intended in this specification to embrace those and similar devices.

BACKGROUND OF THE INVENTION

It will be noted that the terminal-ballistic overall effect consisting of depth of penetration and surface coverage is afforded by virtue of terminal-ballistically active elements such as KE penetrators, hollow charges or projectile-forming charges and by the various fragmentation configurations such as ALP fragmentation configurations and/or fragmentation heads, disk fragmentation configurations, ring fragmentation configurations, P-charge fragmentation configurations or hollow charge fragmentation configurations, in conjunction with blast effects.

In the case of terminal-ballistic action carrier devices of fragmentation or fragment-discharging nature a distinction is usually made between high-explosive projectiles with a fuse device, so-called multipurpose projectiles/hybrid projectiles, being an explosive/fragment action combined with an HC action, warheads, generally with an HC and/or fragment/explosive action, or missiles and in recent times action carriers based on the principle of penetrators with enhanced lateral effect, referred to as PELE, and the principle of active laterally effective penetrators, referred to as ALP. The PELE principle is described for example in DE 197 00 349 C1 while the AL principle is described in detail in EP-A-1 316 774. In accordance with the ALP principle triggering of the lateral operative effects is implemented by means of a device which can be triggered off in the optimum position of the munition body.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved munition device such as a projectile or warhead which uses an active operative body based on the ALP principle in a particularly effective manner.

Another object of the present invention is to provide a munition device operating on the ALP principle affording a range of multipurpose munitions not hitherto achieved and of excellent combinational versatility and overall breadth of effect.

In accordance with the principles of the present invention the foregoing and other objects are achieved by a munition device such as a hybrid polyvalent projectile or warhead having an active means portion delivering active means, the active means preferably being positioned in the nose of the munition or in the region thereof near the nose. An ALP portion preferably arranged behind the active means portion has a terminal-ballistically active casing and an inert pressure transmission medium within the casing. A pyrotechnic device is disposed between the active means portion and the ALP portion both for triggering the active means in the active means portion and also for building up a pressure field by way of the inert pressure transmission medium of the ALP portion.

As will be seen in greater detail from preferred embodiments of the invention as described hereinafter the present invention affords a particularly simple link between the ALP principle and projectiles or munitions with heads or projectile segments delivering fragments or action carriers, insofar as the detonative or pyrotechnic device serves at the same time for both action carriers as a pressure-generating/accelerating element. In combination with the options described in connection with ALP devices for affording multipart/multifunctional projectiles this therefore affords a band width in respect of multipurpose munitions or projectiles, referred to as MP-munitions, which hitherto was not attainable with any previous system and which is also thought to be beyond surpassing in terms of its combinational versatility and overall width of action.

In the case of active devices using the ALP principle, admittedly an inherent velocity is basically no longer a prerequisite for breakup, but with a low impact or interaction velocity, for example when very great combat distances are involved or in the case of basically slow-speed flying threats, the terminal-ballistic action is limited. That operational gap is closed in accordance with the present invention by an additional device which for

example in the form of a pyrotechnic unit such as a P-charge or a hollow charge affords the required effect. In addition disk-shaped bodies such as plate-shaped or annular bodies or corresponding fragment shapes can also be accelerated in the desired directions, for example and more particularly in the axial direction. As that operative mechanism is not yet known in relation to projectiles, it is referred to herein as the 'disk or ring charge'. In general terms the pressure fields produced are utilised for triggering further effects, such as ALP. It is however basically also conceivable for the modules delivering fragments or other active means to be caused to act autonomously in a single-stage mode or a multi-stage structure.

The principle of a multipart munition or projectile or a combined action, referred to as a hybrid projectile, is already implemented in a large number of devices, in which respect tandem hollow charge projectiles and tandem P charge warheads are the best-known representatives. It is however already to be pointed out here that additional active components of that kind can be particularly effectively combined in conjunction with a penetrator in accordance with the present invention. In that respect a particular advantage of the structures presented herein is that for example primarily not only comparable detection and triggering devices are to be employed as in the case of known projectiles or warheads but also, by virtue of the novel active principles or action combinations, it is possible to arrive at structures involving lower levels of technical requirements on devices of that nature. In addition in the present case the situation involves an incomparably greater versatility in terms of combination of different effects. That aspect will be discussed in greater detail hereinafter with reference to the specific embodiments in relation to multipurpose projectiles and munitions in connection with this invention.

In a major extension of the ALP area of use the invention thus concerns an active penetrator, an active projectile, an active missile or an active laterally effective multipurpose projectile, referred to as an MP-projectile or hybrid projectile, in combination with axial and radial fragment modules or separate action carriers with accelerating explosive component. The terminal-ballistic overall effect consisting of fragment effect, disk

effect, depth of penetration as well as axial and radial surface coverage/surface loading is initiated by means of a device which can be triggered in the operative position of the active body for initiating effectiveness or the operative effects involved. Thus the range extends from penetrators which primarily operate on a pyrotechnic basis, for example due to the combination of fragmentation head/ALP portion with or without explosive fragment module, to partially inert projectiles, for example a PELE module and an integrated KE active portion or an KE module alone, with a pure fragmentation head for specific target involvements.

The present invention accordingly links the operative spectrum of the penetrators disclosed in DE 197 00 439 C1, namely PELE, and EP-A-1 316 774, namely ALP, with that of explosive/fragment/disk projectiles, being multipurpose or tandem in nature, and additionally also combines same with functions of fragmentation heads. In that way the properties of the most widely varying munition concepts are combined in a hitherto unrecognised combinational versatility and efficiency in a single action carrier. This not only results in a decisive improvement in multipurpose projectiles but also affords a virtually unlimited extension of the conceivable range of use in regard to all conceivable ground targets from unarmored to more heavily armored objects. In addition suitably designed action carriers of a hitherto unattainable terminal-ballistic power are suitable for combating air and sea targets and also for defense against missiles. With suitable combinations, for example in conjunction with action carriers leading in the axial direction such as P-charges or hollow charges as well as disk or ring charges, such projectiles are also optimally suited for combating reactive targets and also active or distance-operative armor configurations. In that respect the heads discharging disks, by virtue of their relatively large-area target involvement, in conjunction with the high levels of penetration power known from mine plates, which can be a surface charge mine or an EFP mine, of such bodies, are a matter of particular attraction.

As already referred to in EP-A-1 316 774, a difference can be made in terms of technical implementation for triggering the action, as between simple contact firing which is already employed in relation to projectiles of various different design configurations and is therefore readily available, a delay fuse which is also a known arrangement, a proximity fuse design, for example by means of radar or IR technology, and a preset firing point on a trajectory, for example by way of a timer, which can be referred to as time-controllable munitions. In combination with ALP the concept of the invention is substantially independent of the nature of the projectile or the missile such as for example in terms of stabilisation, caliber and the nature of launch or acceleration, for example canon-accelerated or rocket-accelerated, or whether it is in the form of a projectile or a warhead or is integrated thereinto. In particular the arrangement according to the invention does not necessitate velocity of its own for triggering and ensuring even the axial effectiveness thereof at low impact velocities.

Further objects, features and advantages of the invention will be apparent from the description of preferred embodiments set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1A shows a spin-stabilised projectile with a combination of a fragmentation head and an ALP module in accordance with the invention,

Figure 1B shows an aerodynamically stabilised projectile with a combination of a fragmentation head and an ALP module according to the invention,

Figure 1C shows a three-part aerodynamically stabilised projectile with a combination of an HC head, an ALP module and a KE module in accordance with the invention,

Figure 2 shows a nose with integrated action carrier,

Figures 3A and 3B show examples of noses with a fragmentation action,

Figure 4 shows an ALP fragmentation head projectile with in this case four laterally acting fragmentation charges,

Figure 5 shows an ALP fragmentation head projectile with in this case six surface opening charges,

Figure 6 shows an ALP nose module with in this case four inclinedly forwardly and outwardly acting charges such as P-charges or disk or fragmentation charges,

Figure 7 shows an ALP fragmentation head projectile in the form of a fragmentation head with three fragmentation cones,

Figure 8 shows an ALP fragmentation head projectile in the form of a convex fragmentation head of differing coverage filling thickness,

Figure 9 shows an ALP fragmentation head projectile with integrated HC/P-charge module,

Figure 10 shows insert shapes for HC or P charges or disk charges,

Figure 11 shows a graph to illustrate the dependency of the muzzle velocity on the mass to be accelerated for a 120 mm caliber,

Figure 12 shows an ALP projectile with fragmentation head,

Figure 13 shows an ALP projectile with fragmentation head and inner core,

Figure 14 shows a modular projectile or projectile head with core in the nose region, fragmentation portion, ALP module and KE module,

Figure 15 shows a projectile or projectile head with multi-stage fragmentation portion,

Figure 16 shows an example of directionally controlled fragment or disk acceleration,

Figure 17 shows a modular projectile with fragmentation head, core and PELE module,

Figure 18 shows a projectile with fragmentation head, PELE module and core,

Figure 19 shows a projectile head with fragmentation module,

Figure 20 shows a directionally controlled fragmentation charge with lateral tamping,

Figure 21 shows a directionally controlled fragmentation charge with a subjacent inert body,

Figure 22A shows a fragmentation charge with an upper inert body and ring fuse,

Figure 22B shows a fragmentation charge with an outer upper inert body,

Figure 23 shows a fragmentation charge with detonation wave guidance,

Figure 24 shows a directionally controlled fragmentation charge with inert body and multiple detonating charge,

Figure 25 shows a fragmentation charge with chambers for detonation wave guidance,

Figure 26 shows a modular projectile or warhead with fragmentation container pocket and ALP module,

Figure 27 shows a projectile with P-charge head and core with self-destruct charge,

Figure 28 shows an HC warhead with jet focusing,

Figure 29 shows a radially segmented penetrator with central self-destruction device,

Figure 30 shows a projectile with fragmentation head and a central penetrator of a high degree of slenderness with shock damping,

Figure 31 shows a modular projectile with fragmentation head and two-part core,

Figure 32 shows a modular projectile with fragmentation head and multipart core,

Figure 33 shows a modular projectile with segmented central penetrator,

Figure 34 shows a modular projectile with fragmentation head/fragmentation rings and a central long penetrator,

Figure 35 shows a modular projectile with solid nose, fragmentation rings and central core as well as an ALP module,

Figure 36 shows a modular projectile with a long central penetrator, conical fragmentation disks and an ALP module,

Figure 37 shows a view in cross-section of a projectile with a hexagonal central penetrator, flat fragmentation elements and an outer casing, and

Figure 38 shows a modular projectile without a nose/external ballistic cover with fragmentation rings, a long central penetrator and an ALP module.

DESCRIPTION OF PREFERRED EMBODIMENTS

Reference will first be made to Figures 1A through 1C showing embodiments in accordance with the present invention. These involve penetrators with active laterally effective parts in combination with a fragmentation, P-charge, disk or HC head.

Looking more specifically firstly at Figure 1A, shown therein is a shorter version, for example being spin-stabilised, of a munition device in the form of a projectile 1 having a local element 7A which accelerates fragments and which at the same time generates pressure in the subsequent module, for fragment coverage filling as indicated at 11.

Figure 1B shows a longer version 2, being for example aerodynamically stabilised, with a fragment-accelerating element 7B for fragment coverage filling 12, and a central, further, pressure-generating element 9, for example in the form of a fuse cord.

Referring to Figure 1C, shown here is a three-part version 3 which is also aerodynamically stabilised, with an HC head 13, wherein the explosive of the HC portion simultaneously furnishes the pressure for the adjoining ALP module. The casing 4 of the ALP module, which has a terminal-ballistic effect by virtue of the property of its material, its mass and its velocity and which encases the pressure-transmitting medium 6, forms the central unit which forms radial fragments. That unit is adjoined by a KE component. The medium 6 transmits the pressure generated by means of an actuable pyrotechnic device indicated at 7A, 7B and 7C in Figures 1A through 1C respectively, on to the surrounding casing 4, and thus causes it to break up into fragments or submunitions with a lateral component of motion. All the structures shown here are provided with an external ballistic cover 5.

Reference numeral 8 denotes a triggering device which for example can comprise a simple contact signalling device, a timing member, a programmable module, a receiving portion and a fuse component. The device 8 can be connected to the locally concentrated pressure-generating unit 7A, 7B, 7C respectively by means of a pyrotechnic module 9 which is of a cylinder-like or fuse cord-like configuration, as shown for example in Figures 1B and 1C, or by means of a line 10 which can also have pyrotechnic properties, as for example in Figure 1A.

Basically the nose represents a parameter which is essential in terms of the operational efficiency of a munition such as a projectile or warhead. It was already pointed out in EP-A-1 316 774, in which respect reference may be directed to Figure 15 thereof, that the nose can be in the form of a fragmentation module. That aspect is discussed in more detail in DE 197 00 349 C1. Referred to therein as positive examples are noses in the form of a structural space, noses which can be explosively blown off and noses in the form of an ahead-disposed penetrator. The nose can be partially hollow or filled. It is also possible for elements which promote efficiency and effect to be integrated into the nose.

Referring therefore now to Figures 2 and 3A, 3B showing examples thereof, Figure 2, corresponding to Figure 43B in EP-A-1 316 774, shows an active nose module 14 comprising the fragmentation casing 15 in conjunction with a pyrotechnic element 17 and a pressure-transmitting medium 16. It can be fully appropriate here for the nose casing or jacket 18 to be merged with the fragmentation casing 15. An even simpler structure is afforded if the pressure-transmitting medium 16 is omitted. Upon activation the fragments in the direction of the illustrated arrows form a ring which not only implements a corresponding lateral effect but also leads to the expectation of better impact characteristics, even when dealing with relatively sharply or steeply inclined targets.

Reference will now be made to Figure 3A, in which respect attention is directed to Figure 43C in EP-A-1 316 774, showing a nose 19, disposed in front of the ALP module 23, with a pyrotechnic element 17 in a casing 20.

Looking at Figure 3B, in which respect attention is directed also to Figure 43D in EP-A-1 316 774, shown therein is a further nose configuration, for example a nose element 21 which is disposed in front of an ALP module and in which a pyrotechnic module 17 is also disposed in a casing and at the same time projects into the nose which is filled with a medium indicated at 22.

The active components disposed in the front part of the projectile or directly in the region of the nose can, for example in connection with KE modules, be effective separately or can be independently triggered or actuated. Preferably they are combined directly with technical configurations in the context of the present invention, with the aim of optimum overall function. In this respect it is also possible to integrate components which afford a high level of axial operative effect in the event of a correspondingly high propagation or lead velocity, such as hollow charges, shallow conical charges and also disk-shaped or plate-shaped explosive-accelerated projectiles, in which respect attention will be directed at this point to Figures 6, 10, 28 and 35 through 38. Such structures are of particular interest for example when, at the target, prior to impact of the projectile, systems such as for example active and reactive components are to be triggered. Furthermore systems of that kind are particularly suitable for combating deeper target structures, buildings, walls and bunker structures, as the leading active component results in preliminary destruction of such a structure. In that way the following penetrator modules are not prematurely absorbed and dissipated or can penetrate into or through such structures without breaking up and thus implement a particularly effective action.

Munitions and projectiles of this kind, for example in combination with the ALP principle, are excellently well suited for combating approaching in-flight threats such as warheads or combat or reconnaissance drones which cannot be combated with direct hits. Even conventional fragmentation projectiles have little effect in a practical context by virtue of the combat encounter situation with drones and their very limited fragmentation distribution. The mode of operation of the

present invention, in combination with a suitable triggering unit, promises here a hitherto unattainable degree of efficiency.

In regard to the distances relative to the target, which are of interest in this respect, a distinction can be drawn between the immediate near range, namely less than 1 meter, the near range, between 1 meter and 3 meters, the relatively close range, between 3 meters and 10 meters, the medium range, between 10 meters and 30 meters, and the relatively distant range of over 30 meters. In the case of P-charges and also in the case of suitably shaped disk charges, the range over 30 meters can still be a matter of interest as charges already exist, which act over a distance of far above 100 calibers. In this respect also it will be apparent that projectile structures in accordance with the invention afford virtually any range of options for achieving desired effects in accordance with the known or expected target scenario, in a hitherto unattainable band width.

Reference will now be made to Figures 4 through 10 to describe a series of explanatory examples and technical configurations, although it will be appreciated that still further fundamental arrangements are also possible. It will be noted in this respect that the arrows which symbolically denote the resultant of the direction of propagation of the active means or fragments indicate, in terms of their length and thickness, the mass and the velocity respectively of the active components.

Looking firstly at Figure 4 in this respect, shown therein is a cross-sectional view of an ALP nose module 25 with four predominantly laterally effective fragmentation charges 26. They are accelerated by a central explosive body 27. That gives rise to four fragmentation fields or areas with preferred propagation directions as indicated at 30A through 30D. The fields can be varied by virtue of the configuration of the body 27 and the surface configuration as indicated at 29 of the fragmentation bodies 26, that is to say the fields for example can be caused to have more of a scattering effect or can be oriented in more of a focussed fashion. The axial component of the fragmentation velocity can also be increased by tapering of the body 27 towards the nose of the projectile. Other simple possible variations involve the shape, the mass and the material of the fragments

26 or the accelerated effective surfaces. The fragment bodies 26 can also fill the entire space 28 as far as the housing as indicated at 31. It is also possible for the fragment bodies 26 to be made from a pressed material or to be made from a material block which is either accelerated in the form of a disk or plate or which breaks up upon detonation of the body 27. Multilayer and also combined fillings are also possible.

Figure 5 is again a view in cross-section of a further example in regard to the design configuration of a projectile or warhead nose in the form of a module 32 with six laterally effective areal fragment distribution patterns which are formed by a central pyrotechnic module 34 in conjunction with suitable metal inserts 35 of a suitable material such as for example copper, tantalum, tungsten or other materials which are as heavy and ductile as possible and which build up fragment areal patterns in a plurality of and preferably as shown six directions 36A through 36G. It will be appreciated that the number of charges can be freely selected and primarily depends on the dimensions of such a module 32. The housing wall 33, in a suitable design configuration, can also deliver fragments.

Figure 6 is a view in longitudinal section and cross-section through two further variants of a nose configuration in accordance with the invention. Thus, the upper part in Figure 6 shows an ALP nose module 37 with four charges acting inclinedly forwardly and outwardly, as indicated by the velocity resultant 38, being for example P-charges 39, formed from the central explosive element 40 and the metal insert 41. It is also possible to consider corresponding forwardly and outwardly directed fragmentation charges, as indicated by fragment pockets 43, with a velocity resultant as indicated at 42. That technical variant, identified by reference numeral 44, is shown in the lower part of Figure 6.

Reference will now be made to Figure 7 showing two further examples of an ALP nose module 45 with a predominantly axially acting fragmentation head, here being shown in the upper half of the Figure, formed from three fragment cones 47, involving a propagation direction as indicated at 53, behind an external-ballistic cover 48. In accordance with the invention, the acceleration charge 49 for the fragment cones 47 is also

at the same time an element adjoined for example by a further explosive cylinder or explosive cord for actively breaking up the projectile casing 40 by way of the pressure-transmitting medium 51 which here is preferably solid, being for example of metal. It will be appreciated that the charge 49 can also be separate from subsequently detonated or induced-detonation charges, such as for example the charge 9, as indicated in the lower part of Figure 7. Fragment distribution can also be influenced by the nature of the external tamping.

There is a relatively great degree of design liberty in regard to the nature of the fragment filling and the predetermined fragment direction 53. Thus it is possible here to use components which are produced differently in terms of material and shape. A mixture of heavy or large and light or small fragments can also be advantageous. Equally the ring surrounding the acceleration component 49 can be in the form of a fragmentation charge 54, with the propagation direction as indicated at 55, in the lower half of the Figure. It may then be appropriate to provide for a separation 52 between the fragmentation head and the remainder of the penetrator.

Looking now at Figure 8, shown therein are two further examples of an ALP nose module at 56, in the upper part of Figure 8, and at 57, in the lower part of Figure 8, with a fragmentation head. This is again covered by an external-ballistic cover 58. The cover 58 can be hollow, as shown in the upper part of Figure 8, or may contain additional fragments or other active means 59, as in the lower part of the Figure. The propagation direction 61 of the fragments of the fragmentation body 60 can be predetermined by way of a suitable configuration of the surface 64 of the acceleration unit 62. A tampering and at the same time pressure-transmitting medium 63 can be disposed behind the unit 62, and further fragments of any desired shape can also be embedded in the medium 63 in a uniform or non-uniform distribution therein.

As already mentioned the arrangement according to the present invention can be combined in conjunction with further action carriers in a manner not to be attained hitherto. In that respect a suitably designed ALP may already be an efficient multipurpose projectile. Multipurpose projectiles

which are predominantly large-caliber munitions in the caliber range of between 60 mm and over 150 mm primarily involve the purpose of attacking those targets in regard to which the use of projectiles designed for a high penetration capability is not meaningful or is not sufficient alone. That applies equally for more lightly armored pinpoint targets such as for example fixed-wing aircraft and helicopters and for unarmored or more lightly armored ground targets of relatively large extent in terms of area or lighter targets at greater battle distances. Those functions are generally implemented by means of fragment-discharging devices, often in combination with a hollow-charge or P-charge module.

A fundamental advantage of arrangements of the illustrated kind is that practically the entire fragment/subprojectile mass is delivered with structurally predeterminable velocity components primarily in the direction of the target to be attacked. That is of interest in particular from the point of view that for example in the case of conventional multipurpose projectiles a considerable proportion of the fragments is expelled rearwardly and thus remains ineffective. It should be noted here however that arrangements are already known, in which fragments are arranged in the head region of explosive projectiles, including fragments of a geometrical configuration or filling. An advantage of the present invention is that all previously known configurations can be integrated and linked to the components which are specific to the invention.

Figure 9 shows two examples in respect of an ALP nose module 65 with an axially effective component enjoying a high level of penetration capability, as indicated by the direction of action identified at 66, with at the same time lateral components. Shown here is a hollow-charge module with the explosive portion 67 and an insert 68 in the form of a pointed cone, trumpet-shaped, degressive or progressive. A fragmentation ring 54 can also be disposed as a tamping means around the explosive charge 67, as shown in the lower part of Figure 9. The pressure-transmitting medium 70 is to be so selected here that it has a dynamically tamping/supporting effect in regard to the hollow charge. In this respect however, as regards strength and density, a plastic material may already be sufficient. It will be

appreciated that this also applies for the other examples illustrated hereinbefore and the examples which are still to follow.

Various options in terms of the configuration of the insert 68 are shown in Figure 10. They extend from pure HC inserts 68 for the formation of high-velocity hollow-charge jets with nose velocities of up to over 8000 m/s, as indicated by the slender velocity arrow 66, by way of shallow-cone or hemispherical inserts 71 forming projectiles, which can produce a P-charge 73 which still precedes at between 2000 m/s and 3000 m/s the projectile as it approaches the target or impacts against a target, as indicated by the thick, relatively short velocity arrow 69. In addition the axially accelerated active portion can also comprise a plate-shaped, disk-shaped or ring-shaped overlay 74 which can achieve velocities of between a few 100 m/s to 2000 m/s. It is to be noted in this respect that the above-specified velocities are to be added to the respective projectile/warhead velocity. This means that disk designs of that kind can achieve penetration capabilities which are comparable to those of P-charge mines. Disk-type heads of that kind can also be made up from two or more disks which can comprise different materials also of different thicknesses. For the purposes of better dynamic separation it may also be appropriate to insert a pyrotechnic or a pressure-transmitting medium between the individual disks.

It is to be noted here that arrangements are already known in which an HC component, being a preliminary hollow charge or pre-charge, is disposed in front of a primary charge of an HC projectile, in particular for triggering reactive targets, referred to as tandem charges. It is however once again an aspect of particular advantage with the present invention that all hitherto known preliminary hollow charges can be integrated and linked to the components specific to the present invention. Here, in contrast to tandem hollow charges, the pre-charge which is positioned in the path of the primary charge does not have any efficiency-reducing effect but benefits the overall effectiveness of a projectile in accordance with the invention to the full extent. These considerations also apply in regard to ahead-positioned P-charges.

The combination of pyrotechnically accelerated elements in the form of plates, disks or rings, in conjunction with a projectile as it approaches the target or impacts against a target is hitherto not known. By virtue of the large action diameter thereof in conjunction with the leading nature thereof such components are particularly suitable for effectively attacking reactive targets.

Independently of the individual munition concepts involved, in the case of barrel-launched munitions it is the efficiency of the canon or gun that is the crucial parameter. Reference will now be made to Figure 11 showing the muzzle velocity which can be achieved with predetermined masses to be accelerated, being referred to as the overall or barrel masses, for a 120 mm caliber, as denoted by the solid line. With a mean muzzle velocity of between 1100 m/s and 1300 m/s in accordance therewith masses of between 16 kg and 22 kg are to be accelerated. If consideration is given to a subcaliber ratio of 2:1, corresponding to a flying projectile diameter of 60 mm, and a ratio of 4:3, corresponding to a projectile diameter of 90 mm as a subcaliber ratio at the highest level from the external-ballistics point of view, then with an assumed cartridge-case base mass of 3 kg and 4 kg respectively, that gives penetrator masses of between 13 kg and 18 kg. As those projectiles are to be approximately equated in terms of the external-ballistic characteristic data with corresponding arrow-type projectiles (double the flight diameter with four times the mass), such projectiles can be reckoned to involve a mean fall in velocity of about 50 m/s at 1000 m. The impact velocities at a battle range of 4000 m are thus between 900 m/s and 1100 m/s.

With the above-specified values a still quite considerable terminal-ballistic effectiveness on the part of a projectile in accordance with the invention is also to be expected, both in the form of a KE or PELE projectile and also an ALP device. An assumed mean mass for the penetrator of 16 kg could then be divided up for example as follows, with a muzzle velocity of 1200 m/s: mass of the fragmentation/subprojectile casing 8 kg, mass of a central penetrator, being a central or axial element, 3 kg, mass of the pressure-producing elements 0.2 kg, mass of the pressure-

transmitting/additionally operative media or active portions 2 kg, mass for fragment-delivering nose or HC- or P-charge nose, guidance mechanism and other elements 2.8 kg.

Figure 11 also records the power field which occurs when consideration is given to the internal-ballistic power increases which already appear in accordance with publications, for example by means of DNDA (di-nitro-di-aza)-propellant charge powder. In accordance therewith it is possible to assume an increase in muzzle velocity of between about 100 m/s and 120 m/s, as indicated by the broken-line functional curve. The resulting displacement of the design range both in terms of a desired increase in velocity, as indicated by the direction A, and also in terms of a larger firing or penetrator mass, as indicated by the direction B, is shown here. Thus the above-estimated projectile involving a mass of 16 kg can be fired at about 1300 m/s. Alternatively it is possible to accelerate a projectile mass, being referred to as the barrel mass, of between 22 kg and 23 kg, constituting a mean penetrator mass of 20 kg, at about 1200 m/s. As the above-assumed masses for cartridge case base, nose and tail and for the additional devices remain practically unchanged, in this case it is possible to assume a mass for the projectile/fragmentation casing of 10 kg with a mass for the central penetrator of again about 4 kg. A mass of about 3.5 kg would then be available for the head. This would therefore involve quite considerable projectile or warhead noses. Under those conditions it is also possible to forego a central penetrator, with a casing mass which is then possible of 14 kg. Basically, in the case of flying objects, the fragmentation penetration capabilities due both to the nose or rather the region near the nose and the projectile are at any event sufficient to attack even hardened or armored targets.

Thus a projectile corresponding to the configuration implemented in connection with Figure 11 is capable of penetrating even relatively heavy armor. In conjunction with the lateral effects corresponding to the present invention such projectiles or warheads make ideal multipurpose projectiles. For the first time they are in a position of being able to be used against almost the entire spectrum of targets, with a single effect carrier. A further

increase in effectiveness can be achieved with such devices by virtue of their technical advantages still further than in the case of conventional projectiles, for example by means of projectile control or at least final-phase guidance.

When estimating the terminal-ballistic power, it is to be noted that, by virtue of their very large and in particular dynamically increasing diameter upon penetration in particular of partition targets or reactive armor arrangements, penetrators of that kind can achieve penetration capacities which are to be compared to those of high-efficiency penetrators or even exceed same. In conjunction with structural measures, as noted hereinbefore with reference to Figures 9 and 10, and in particular by virtue of the incorporation of subpenetrators comprising for example hard metal and heavy metal, as shown for example in Figures 13, 14, 17, 18, 27 and 30 through 38, even considerably greater penetration capabilities are to be achieved in relation to a whole series of targets.

With a suitable assessment in respect of another caliber, it is possible to take as the basis for consideration in this respect either a cranesbill-like increase or reduction, or for example a length which is kept constant. In the former case the masses alter approximately with the third power of the dimensions, in the latter case with the square of the change in diameter. In the case of an assumed transition from 120 mm to for example 155 mm, with the cranesbill-like configuration that thus gives the factor of 2.16 while with a projectile length which is kept constant the factor is 1.67.

Reference will now be made to Figures 12 through 8 and 26 through 38 showing further embodiments of munition devices in accordance with the present invention.

Thus, considering firstly Figure 12, shown therein is an ALP with fragmentation head in the form of a spin-stabilised device. The ALP module has a casing with an internal cone as indicated at 76.

Figure 13 is a view corresponding to Figure 12 illustrating a projectile corresponding thereto, but also with an additional internal core indicated at 78. It can comprise heavy metal, hard metal or hardened steel. The cap or

cover 77 protects the hard core from unacceptable shock loadings, for example when the device impacts against massive or highly resistant targets. The triggering or control unit 8 is here protected by a strong sheath 75. The latter also serves to ensure the pressure in the pressure-producing medium 6 for breaking up the casing 76.

Projectiles with hard cores as shown in Figure 13 are particularly suitable for relatively low impact velocities, for example below 800 m/s to 1000 m/s. Here, the hardness of a penetrator still plays the dominant part in terms of penetration capability. At velocities above 1000 m/s the density of a penetrator increasingly gains in significance. Then for example heavy metal cores are advantageously employed. In the case of projectiles in accordance with the invention with incorporated hard cores, even at relatively low velocities of for example between 400 m/s and 600 m/s, particularly then in comparison with penetrators which are designed for high impact velocities, considerable penetration capabilities are still to be expected if the core is not destroyed upon penetration occurring. In that respect, with a constant impact velocity, the specific loading of the core, in relation to surface area, is the crucial parameter in terms of penetration capability, that is to say in a first approximation being the length of the core.

Reference is now made to Figure 14 showing a further basic example of a modular projectile 79 with a core 80, for example of hard metal or heavy metal, in the nose region. It can either be arranged within an external-ballistic cover 5 or it can replace same, also partially. Connected subsequently thereto is the fragment-delivering portion with a pyrotechnic unit 82 which is here of a conical configuration. The fragments 81 are preferably expelled in the direction indicated at 84, in which respect the conical rear 83 of the core 80 implements an additional radial component.

An example of a particular fragmentation projectile is shown in Figure 15 to which attention is now directed. This involves a projectile as indicated generally at 85, or a projectile head, with a two-stage fragmentation portion formed as illustrated from pyrotechnic units 86 and 87 and the fragment fillings 88 and 89, and a subsequently disposed ALP

module. The resultants of the accelerated fragments is indicated by the arrow 90 in respect of the fragments 88, the arrow 91 in respect of the fragments 89, and the arrow 92 in respect of the housing 4. This example can also be combined with a directionally controlled fragmentation acceleration means as indicated at 93 in Figure 16. Here the fragment filling 95 is subdivided into four fragmentation segments 95 by means of partitions 94 so that the segments 95 can also be actuated separately, with the corresponding resultant fragmentation effect being identified by the arrow 96.

Attention is now directed to Figures 17 and 18 showing examples of multipurpose projectiles 97 and 99 respectively with cores and ALP- and PELE-module respectively. Thus Figure 17 shows a fragmentation head comprising the components consisting of explosive 62 and fragments 61 positioned in front of a hard metal or heavy metal core 98 which displaces a crater in front of the following PELE-module. The explosive 62 is fired again by way of the element 8 and the control or connecting line 10. The line 10 can either extend in the wall 4 of the casing or can be disposed directly in the pressure-transmitting medium 6, as shown for example in Figure 18. In that way a high level of fragmentation effect is achieved in the head region with a high degree of penetration capability in combination with a delayed PELE-effect and a correspondingly large lateral extent, in that the PELE component which follows on is pushed in the crater over the core or is further upset thereby.

Looking at Figure 18, shown therein is a multipurpose projectile in which the sequence of modules disposed after the fragmentation head is reversed in comparison with the structure shown in Figure 17. Here the fragmentation head/ALP portion form the fragment-producing components, followed by a hard-metal or heavy-metal core 100 to achieve a high penetration effect.

The shape of the fragment-accelerating elements with effects primarily in the firing direction is to be suitably matched to the desired manner of fragment distribution. Basically, upon acceleration of the fragments in the axial direction, this involves flat pyrotechnic elements as

indicated at 105 for example in Figure 20, being for example of a disk shape or ring shape, which for example can be provided with a shallow internal cone as indicated at 107 for example in Figure 20 for fragment focussing, or with a shallow or steeper external cone as indicated at 113 in for example Figure 12, in which respect attention may also be directed to Figure 7, or a slighter convex curvature, in which respect reference may be made to Figures 8, 17, 18, 19 and 30 through 34, or a more strongly convex shape, as shown for example in Figures 1B and 8, for radial fragment distribution.

In addition to the above-indicated geometrical measures, it is also possible to provide for directional control of the fragments. This is an aspect which is of particular interest in connection with an intelligent projectile or warhead. Reference will therefore now be made to Figures 19 through 25 showing embodiments in respect of uses of that nature. In this respect Figure 19 serves to illustrate the region which is to be considered in greater detail in this connection. A tamping effect is afforded either by way of an outer ring indicated at 109 in Figure 30 or by way of the projectile casing indicated at 110 in Figure 21. If the fuse 108 is disposed more within the charge 105, as indicated at the left-hand side in Figure 20, then in general the inherent tamping effect afforded thereby will also suffice.

In order to achieve a given direction of propagation, involving fragment guidance, in respect of the fragment filling 106, a plurality of fuses or firing charges 108 which are to be actuated separately, as shown in Figure 20, can be arranged for example at the periphery of a pyrotechnic acceleration element indicated by reference 105. That directional effect can be further enhanced by structural features. Thus for example the arrangement illustrated at reference 111 in Figure 21 has a rear inert body 112 for shock wave guidance. Figure 22A shows a further example as illustrated at 114. There, the shock waves which are produced after firing of the explosive 105 by means of the charge 108 are deflected by way of an inert body which is at the front, as viewed in the direction of firing, with an internal cone 115. It is also possible to envisage an annular firing charge as

indicated at 108A in Figure 22A. An external cone 115B for shock wave deflection is likewise possible, as indicated in Figure 22B.

Fragmentation head shock wave guidance is also an option that can be considered, in a logically consistent configuration of that structure. The notion of shock wave guidance is basically known in relation to hollow charges or P-charges, for deflection or better distribution of shock waves in the charges which accelerate the inserts. In that case however it is primarily intended to implement better shock wave symmetry and thus more precise jet formation. In contrast thereto the proposal in accordance with the invention is to achieve the effect of shock wave guidance by means of bodies introduced into the fields of propagation of the shock waves, affording asymmetrical distribution of the shock waves and therewith the shock wave energy, in order for example to provide a fragment filling with irregular distribution or to impart thereto a particular direction, thus furnishing a fragmentation head shock wave guidance effect. That phenomenon can be assisted by suitable fragment distribution of the fragmentation surface 106 and/or the configuration of the surface of the pyrotechnic element 105, for example it can be concave, convex or conical.

Looking now at Figures 23 through 25, shown therein are further examples of fragmentation head shock wave guidance or deflection. Thus Figure 23 more specifically shows a shock wave-guidance body 117 introduced into the explosive 105 in the structure 116. The body 117 can be of a metal compound or can comprise plastic material or substances which support and assist the explosion effect.

The arrangement indicated at 118 in Figure 24 incorporates a plurality of fuses 108 separated by a partitioning wall 119. A desired direction can be predetermined here, by virtue of a different triggering or firing pattern for the fuses. The incorporated front conical inert body indicated at 115 in Figure 24 promotes that effect.

Figure 25 shows an arrangement 120 in which the individual fuse/acceleration elements 121, which can be for example in the form of a ring of explosive, are disposed in suitably shaped pockets between inner and outer inert bodies 122 and 123 for shock wave guidance. With a

suitable configuration however this arrangement may also have only a single inert body with recesses therein. In the case of larger systems it is also possible to achieve a desired asymmetrical acceleration of the fragments by way of displacement of the fuse 108 in the explosive body 105.

Figures 26 through 38 show further configurations of munition devices in the form of projectiles or warheads in accordance with the present invention to supplement or expand the technical configurations of the invention. Thus, looking firstly at Figure 26, shown therein is a further basic structure for a munition device 124 in the form of a projectile or warhead. This in principle involves an ALP which in the rear portion is of a known configuration while the front portion comprises a fragmentation chamber 127 in which fragments 128 are embedded in a matrix material. A charge 126 which is fired by way of a triggering or control unit 8 accelerates both modules of the munition device. While the rear portion is destroyed laterally at relatively low viscosity, as indicated for example by the resultant arrows in respect of velocities and masses 130A and 130B respectively, the fragments 128 in the rear portion of the chamber 127 are accelerated more radially due to the inherent tamping effect due to the front material, in the case of a thin, that is to say self-destructing wall, as indicated by the resultant arrow in respect of velocity and mass 131, while in the front portion the effect is predominantly axial, as indicated by the arrow in respect of velocity and mass 132. In the case of a more massive or solid wall or with a lower level of axial acceleration in respect of the charge 126, it is also possible to provide for purely axial ejection of the fragments 128 out of the container means 127 formed for example by a pocket. It is also possible to envisage a fragment-filled nose 125, as shown in the lower half of Figure 26, with a corresponding resultant arrow 125A.

It will be noted here that if the structure involves a projectile in accordance with the invention with an HC- or P-charge head, as shown for example in Figures 1C, 9 and 28, then the overall energy balance sheet can no longer be exceeded. Thus for example the striker effect which occurs upon jet formation and on which the jet which axially propagates at high

velocity relies is urged into the ALP module and thus enhances the lateral efficiency thereof.

Figure 27 shows a projectile according to the invention with a P-charge head and a core with a destruction charge 135 in the form of an explosive cord. To simplify the view here control and fuse elements are not illustrated. The central charge 135 can be so designed that, when dealing with homogeneous targets, in spite of firing, it cannot overcome the pressure which is applied from the exterior, so that the core can penetrate in quasi-homogeneous fashion through the target. In the case of thin targets or when dealing with targets of low strength the pressure applied by the charge 135 is sufficient to destroy the core so that it can break up into a plurality of fragments and thus produces its effect in the target, with a corresponding lateral action, as can also be seen from Figure 29.

Figure 28 shows an HC-warhead 136 with a device 137 for jet focusing. This example involves a trumpet-shaped insert 138 for achieving high jet velocities. Reference 137 denotes a body defining a passage which in this case also is of a correspondingly slender configuration. It is also possible for the passage-forming body 137 to be made from a fragment-forming medium.

Looking at Figure 29, as a supplemental aspect in relation to the structure of Figure 27, it is also possible to provide a radially segmented module 140 which in this case is formed from four segments each indicated at 142, with a destruction charge 141. The resultant arrows 143 are illustrated in this Figure.

Figure 30 shows a projectile 144 with fragmentation head, an ALP module with a long and slender central penetrator 145, affording a high degree of slenderness for giving a level of penetration capability which is as high as possible. The tip of the penetrator 145 is protected by means of a cap or hood, a cylinder or a comparable configuration as indicated at 146, from shock or impact loadings of the pyrotechnic unit and also due to impact and upon penetration into a target, in which respect attention may be directed to Figure 13 and the description relating thereto in respect of similar considerations.

Figure 31 shows a projectile 147 according to the invention with a fragmentation head and a composite core 148 which here is of a very large configuration. It comprises for example a hard metal tip 149 and a rear core portion 150 for example of heavy metal. The connection between 149 and 150 is effected here by means of an intermediate layer 151. This represents a connection which for example comprises adhesive, vulcanisation, frictional welding or soldering. It will be appreciated however that any other suitable form of connection can also be adopted in this respect, for example of positively locking nature or force-locking nature. Composite cores of this kind also enjoy the advantage that they can be machined in the heavy metal or steel portion. The interface between the components 149 and 150 can also be of a conical configuration in order to ensure that, upon deceleration of the tip 149, the heavy metal cylinder 150 is dynamically upset against the rearward surface of the hard core 149.

Supplemental to Figure 31, Figure 32 shows a modular projectile 152 with a further core structure involving a hard metal tip 149 and a rear core portion 154 supported by a sleeve 153. The sleeve 153 can comprise for example another hard metal, a heavy metal, steel or another strong material. The inner shank portion 154 of the core can be joined to the tip 149, it can form one piece therewith, or it can simply be inserted therein. It is also possible for the rear portion of the core to be of a conical shape, for example to reduce friction when penetrating deep targets.

In Figure 33 the central core comprises a segmented arrangement as indicated at 156. The projectile or missile generally indicated at 155 again comprises a fragmentation head with adjoining ALP module. If the pressure-transmission medium 6 comprises a solid material such as for example magnesium, aluminum or GRP, the segmented penetrator 156 can be introduced thereinto by means of a suitable bore. If the medium 6 comprises a liquid or a substance which mechanically is not sufficiently stable, for transmission of the launch acceleration, the penetrator 156 could be provided with its own casing as indicated at 153. In the present structure the central penetrator 156 comprises two forward cores 157 which preferably consist of hard metal or heavy metal with a low degree of

slenderness, more specifically a low length/diameter ratio, with the cores 157 being separated by means of a buffer as indicated at 160. The buffer 160 can also comprise the same material as the pressure-transmitting medium 6. The rear core portion is here formed from two more slender cores 158 with a higher degree of slenderness, that is to say a higher length/diameter ratio. A shock-reducing layer 159 can be disposed between the cores 158. The layer 159 can also separate two cores 158 which are of different materials.

Referring to Figure 34, shown therein is a munition device 161 in the form of a projectile or warhead whose front fragmentation component is formed from a fragment-delivering nose and a stack of fragmentation disks 163 and respective pyrotechnic elements 164. They are followed either by a solid shaft portion or an ALP module, in which respect a comparison may be made with Figure 35. The Figure 34 example also includes a long central penetrator 162 which is either of a solid massive structure or which is disposed in a casing as indicated at 165. It will be appreciated that the disks 163 may also be arranged without intermediate pyrotechnic layers therebetween, but that then does not ensure the desired separation effect.

In the case of the modular projectile 166 shown in Figure 5, the fragment-delivering nose is replaced by a solid nose 167. The nose 167 can penetrate for example relatively heavy pre-target structures in order in that way to permit the remaining penetrator to pass therethrough so that then the fragment-delivering disks 163 which are accelerated by the interposed pyrotechnic elements 164 can radially open. By means of a conical tip, disks of that kind can also have a mechanically implemented lateral component, due to the expansion effect imparted thereto.

Further nose and penetrator configurations will now be described with reference to Figures 36 through 38. Thus Figure 36 shows a projectile or warhead 168 having a central penetrator 169 which extends over the entire length thereof and which is surrounded in the front portion thereof by rings or ring segments as indicated at 171. They can be of a conical configuration in the manner of plate springs, to promote the lateral components, as indicated by the resultant arrow 173 in Figure 36. The

disks are accelerated by the flat pyrotechnic elements 172 interposed therebetween. The remainder of the projectile is in the form of an ALP module which is here subjected to a pressure loading by its own pyrotechnic element 170. The central penetrator 169 is provided with its own tip 174. The tip 174 can also be of a stepped configuration, as well as an ogival or conical nature.

Figure 37 shows an alternative configuration of the structure shown in Figure 36, indicated generally by reference 175. Here the central penetrator 177 is of a hexagonal cross-section. It is surrounded by six flat elements 176, in each layer or plane. The elements 176 are held together by an outer ring or casing 178. The casing 178 can also be in the form of a fragment-forming sheath. It will be appreciated that further geometrical configurations are also possible, according to the technical requirements involved or the desired effects to be achieved.

Particularly in the case of missiles or when very large calibers are involved the launch or departure velocity is generally low, for a caliber of 155 mm for example being about 800 m/s. Thus, at very great battle ranges, for example of 20 kilometers, it must be considered that the impact velocities are relatively low, for example between 400 m/s and 500 m/s. The nose shapes to be used are determined by external ballistics. When low velocities are involved, it may certainly be appropriate to deviate from a conventional nose shape or to forego an external-ballistic cover. Stepped noses can also be adopted, which are to be dimensioned solely in consideration of terminal-ballistic considerations, for example in order better to attack inclined or oblique target surfaces.

In the alternative configuration of a projectile structure 179 according to the invention, as shown in Figure 38, the disks 180 involve a different cone angle and a differing thickness, with suitably adapted pyrotechnic elements 181. In flight or on approaching a target the cover can also be mechanically removed, for example by being pivoted open, discarded, blown off by explosive means or eroded during the flight of the projectile.

It will be appreciated that more complex design configurations of the fragmentation systems depend primarily on the caliber of the munition and there in a first approximation with the third power of the caliber. While the fundamental idea of the present invention can certainly already also be appropriate in relation to smaller calibers or projectile diameters, depending on the respective technical expenditure involved, more expensive and complex structures will generally be reserved for medium and in particular larger calibers, as for example from 60 mm, or large-size calibers, for example from 90 mm.

It will be noted at this point that EP-A-1 316 774 already referred to the possibility of also using the ALP principle in relation to high-velocity torpedoes. In that case however the impact velocities are at the lower appropriate limit of use. The technical configurations in accordance with the present invention permit a crucial increase in efficiency insofar as active bodies adapted to the spectrum of uses are accelerated directly prior to or during impact out of the projectile or insofar as a high level of lateral and axial effect is triggered upon impact. As noted axially accelerated active bodies to be considered here are in particular suitably designed P-charges and higher disks or rings, optionally with a particular configuration for use under water.

A hybrid polyvalent active system in accordance with the invention is also suitable, besides launch by means of guns and canons, for launch by means of rockets, missile defense systems, controlled or guided bombs or missiles including cruise missiles. The virtually unlimited freedom of design in connection with virtually all known active mechanisms means that it is possible with systems of this nature to attack from heavily armored ballistic targets, through large-area and/or deep target structures such as relatively light targets, aircraft, ships or buildings, to strategic targets.

The invention thus provides a hybrid polyvalent projectile or multipurpose projectile or a hybrid polyvalent warhead or missile with fragmentation, disk, ring, hollow-charge or P-charge head in conjunction with a module comprising an active laterally effective penetrator, referred to as an ALP. In this case action carriers based on the ALP and PELE

principle including KE-penetrators and projectors with fragmentation heads or devices accelerating active bodies axially are actively technically optimally combined by the pyrotechnic unit serving at the same time for the ALP and the pyrotechnic active means as a pressure-producing or accelerating element. The terminal-ballistic effectiveness of ALP projectiles, which is reduced at low impact velocities, is ensured by an additional device which as a pyrotechnic unit, for example a P-charge, hollow charge, disk-charge or ring-charge, produces an axial action and accelerates fragments in the desired direction. That can afford projectiles or warheads with an efficiency balance sheet and action band width which could hitherto not be achieved and which can no longer be surpassed in terms of its combinational versatility and overall breadth of action.

It will be appreciated that the invention may be implemented in various different ways, in which respect attention may be directed to Figures 1A through 1C showing an embodiment with an external-ballistic cover, the Figure 1A being a shorter unit in the form of a spin-stabilised projectile with an element actuated by way of a signal line for accelerating fragments and at the same time producing pressure for the ALP portion with a pressure-transmission medium and casing. Figure 1B on the other hand is a more slender and longer design with a fragment-accelerating element for the fragmentation sheathing and a further pressure-producing element for the ALP portion. Figure 1C is an aerodynamically stabilised projectile of hollow-charge head kind, while the explosive of the HC portion with the triggering device can be of any design configuration and at the same time providing the pressure for the adjoining ALP module.

It will be appreciated that the above-described embodiments of the invention have been set forth solely by way of example and illustration of the principles of the invention and that various other modifications and alterations may be made without thereby departing from the spirit and scope of the invention.